The Potential of Phased Arrays for Planetary Exploration

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Phased array antennas provide a set of operational capabilities which are very attractive for certain mission applications and not very attractive for others. Such antennas are by no means a panacea for telecommunications. In this paper the features of phased arrays are reviewed and their implications for space missions are considered in terms of benefits and costs.

The primary capability provided by a phased array is electronic beam agility. The beam direction may be controlled at electronic speeds (vs. mechanical actuation) permitting time division multiplexing of multiple "users." Moreover, the beam direction can be varied over a full hemisphere (for a planar array). On the other hand, such antennas are typically much more complicated than the more commonly used reflectors and horns and this implies higher cost. In some applications, this increased cost must be accepted if the mission is to be carried out at all. The SIR-C radar is an example of such a case albeit not for deep space. Assuming for the sake of argument that the complexity and cost of a phased array can be significantly reduced, where can such antennas be of value in the future of planetary exploration?

Potential applications to be discussed are planetary rovers, landers, and orbiters including both the areosynchronous and low orbit varieties. In addition, consideration is given to links from deep space to earth. As may be fairly obvious, the deep space link to earth would not benefit from the wide angle steering capability provided by a phase array whereas a rover could gain advantage from the capability to steer a beam anywhere in the sky. In the rover case, however, physical size of the aperture becomes a significant factor which, of course, has implications regarding the choice of frequency band.

Recent research work concerning phased arrays has suggested that future phased arrays might be made less complex and, therefore, less costly. Successful realization of such phased arrays would enable many of the planetary missions discussed in this paper and significantly broaden the telecommunications capabilities available to the mission designers of the future.